(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 June 2001 (14.06.2001)

PCT

(10) International Publication Number
WO 01/42065 A1

(51) International Patent Classification[7]: B60R 22/34, 22/28, 22/44, 22/46

(21) International Application Number: PCT/US00/29492

(22) International Filing Date: 26 October 2000 (26.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
199 59 956.4 13 December 1999 (13.12.1999) DE

(71) Applicant: BREED AUTOMOTIVE TECHNOLOGY, INC. [US/US]; P.O. Box 33050, Lakeland, FL 33807-3050 (US).

(72) Inventors: SPECHT, Martin; Im Harl 4, D-82340 Feldafing (DE). LIEDL, Christian; Sieghart Strasse 4, 80995 München (DE).

(74) Agents: DRAYER, Lonnie, R.; Breed Automotive Technology, Inc., P.O. Box 33050, Lakeland, FL 33807-3050 et al. (US).

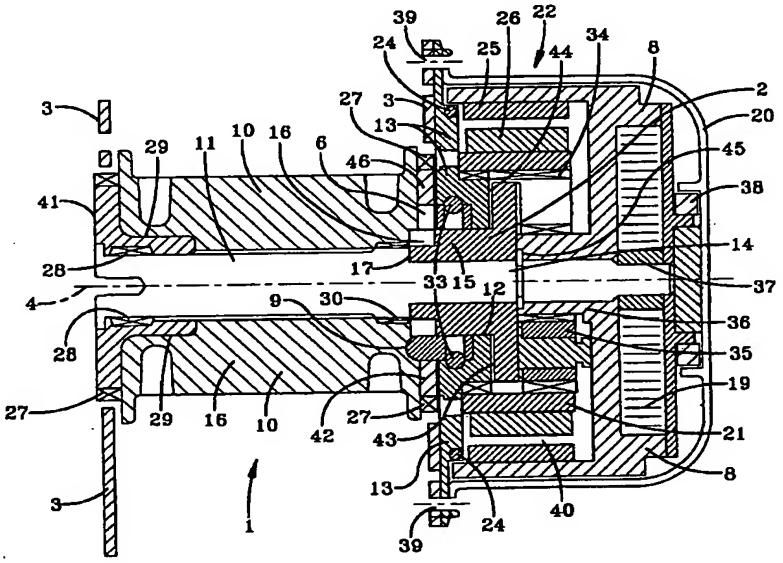
(81) Designated States *(national)*: AT, AU, BR, CA, CN, CZ, DE, DK, ES, FI, GB, HU, ID, IN, JP, KR, MX, NO, NZ, PL, PT, RU, SE, TR, YU, ZA.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SEAT BELT RETRACTOR



(57) Abstract: A seat belt retractor has a belt reel (1) mounted rotatably around a reel axis (4) on a retractor frame (3) and biased by a motive spring (19). A load limiter (11) is non-rotatably connected to a rotatable spool (10) of the belt reel. A rotor (2) can be coupled to the belt reel and/or its load limiter by a coupling (9), wherein the coupling (9) comprises an annular carrier (6) connected non-rotatably to the belt reel (1) and/or the load limiter (11) for guiding coupling elements (7) between a released and an engaged position and the annular carrier (6) is arranged coaxially around a bearing collar (15) provided on the rotor (2) and is supported against axial displacement on the adapter flange (13).

WO 01/42065 A1

SEAT BELT RETRACTOR

The invention relates to a seat belt retractor.

In a seat belt retractor described in DE 199 27 731 A1, the rotor transmits the torque of an electric motor to the belt reel and/or the load limiter. The rotor is a planet wheel carrier of a planetary gear connected between the electric motor and the belt reel or the force limiter. A suitable mounting for this rotor is described in DE 199 40 034 A1, the rotor being mounted with a bearing collar externally in a cylindrical outer bearing formed on an adapter flange connected rigidly to the frame. Internally, the rotor is mounted on a bearing journal extending coaxially to the reel axis.

DE 199 50 855 A1 describes a seat belt retractor in which the rotor serves to transmit a torque, resulting from an inertial force, onto the belt reel and/or the load limiter.

With a seat belt retractor of this type, high forces are transmitted via the coupling via the rotor onto the belt reel or the load limiter, in particular in the event of a crash.

It is therefore the object of the invention to provide a seat belt retractor of the type mentioned at the outset in which a perfect coupling function is also achieved during the transmission of high forces.

According to the invention, this object is achieved by the characterising features of claim 1.

As described, for example, in DE 199 40 034 A1, the rotor is mounted externally in a cylindrical external bearing formed on an adapter flange connected non-rotatably to the frame. The rotor is mounted

internally on a bearing journal extending coaxially to the reel axis. The annular carrier used to guide the coupling elements between a released and an engaged position is arranged coaxially around the bearing collar of the rotor and is supported against axial displacement at least on the adapter flange. Preferably, this support is achieved by an interlocking connection between the annular carrier and the adapter flange. For this purpose, the annular carrier can be lengthened and can penetrate into a corresponding recess in the adapter flange. The adapter flange can be held securely in this recess by a securing means, for example a double needle. The annular carrier can be connected integrally in one piece to the spool that is also rotatable during the action of the load limiter. Preferably the annular carrier is hardened externally. Instead of the integral connection with the rotatable spool, the annular carrier can be connected non-rotatably to the spool, for example by a press fit or the like.

Preferably, the annular carrier is secured against axial displacement on one side by the belt reel and/or the load limiter and on the other side by the adapter flange.

Advantageously, moreover, the rotor is supported against axial displacement on both sides of the adapter flange. For example, the rotor can rest with one rotor face on one side of the adapter flange and via a securing disc on the other side of the adapter flange.

The annular carrier connected non-rotatably to the belt reel with a press fit or the like can rest against an end face of the belt reel and/or against a

peripheral bearing shoulder of the load limiter preferably a torsion bar.

The electric motor is preferably a brushless d.c. motor. It is preferably a flat motor, as described in DE 43 02 042 A1. In this flat embodiment, an internal rotor can be used as motor rotor instead of an external rotor. The internal rotor is arranged with its rotor poles are permanent magnets radially inside the field windings of the stator poles. The stator poles are provided on a stator carrier that is preferably fastened on the adapter flange.

The motive spring can be supported on the adapter flange or a casing fastened on the adapter flange via the motor rotor. For this purpose, the outer fixing point of the motive spring is rigidly connected to the motor rotor and the motive spring preferably acts with its spring core via the bearing journal on the belt reel and/or the load limiter.

A mechanical, preferably resilient serration for the motor rotor can also be supported on the adapter flange. The geometric arrangement of this mechanical serration is such that the motor rotor is stopped in specific rotational angle positions in which a startup of the electric motor is always ensured owing to the division ratio of the rotor and stator poles.

Hall sensors can also be provided on the adapter flange, which are influenced by the magnetic field of the respective rotor poles so that the switching of the brushless electric motor can be controlled as a function of the probe signals. Scanning of the respective rotational angle position of the motor rotor is therefore also possible, so that it can be

used, for example, when adjusting the spring force of the motive spring by electronically controlled adjustment.

Brief Description of the Drawings

Embodiments of the invention will be described in more detail with reference to the figures, in which:

Fig. 1 is a cross-sectional view of a first embodiment of a seat belt retractor;

Fig. 2 is a cross-sectional view of a second embodiment of a seat belt retractor;

Fig. 3 is a cross-sectional view of a third embodiment of a seat belt retractor;

Fig. 4 shows a design for a coupling which can be used in the embodiments of a seat belt retractor shown in the figures; and

Fig. 5 is a cross-sectional view of a fourth embodiment of a seat belt retractor.

Detailed Description of the Invention

The seat belt retractors shown in the embodiments have a belt reel 1 that is mounted rotatably around a reel axis 4 in a retractor frame 3. During normal vehicle operation the belt reel 1 is biased in the belt winding direction by a motive spring 19, as will be described in detail hereinafter. A seat belt 5 (Fig. 2) is wound onto the belt reel 1.

The belt reel 1 comprises a rotatable spool 10 on whose reel body the seat belt 5 is wound, as shown schematically in Fig. 2. At its two end faces, the belt reel 1 has blocking discs 41 that carry blocking teeth 27 at their periphery. Blocking means, for example blocking latches, by which the blocking discs 41 are supported non-rotatably on the retractor frame 3, can be brought into engagement with the blocking teeth 27 for blocking the belt reel 1 against further rotation.

This blocking is sensor-induced, for example in the event of a crash. To limit the loading of the seat belt 5, secured by the blocked belt reel 1, on the body of the strapped-in person, a load limiter 11 in the form of a torsion bar extends through the interior of the hollow reel body. The load limiter 11 is connected non-rotatably to the left-hand blocking disc 41 via a fixed bearing 28. At its right-hand end, the load limiter 11 is connected non-rotatably to the spool 10 via a connecting point 30 which can be designed, for example, as a groove toothing or the like. On the left-hand side there is a movable bearing 29 between the spool 10 and the load limiter 11. Thus, the spool 10 is able to rotate in relation

to the region of the fixed bearing 28 during corresponding loading owing to forward displacement of the vehicle occupant's body, for example in the event of a crash. The absorption of energy occurring in the load limiter (torsion bar) 11 causes a deformation of the load limiter. The load exerted on the vehicle occupant's body by the seat belt 5 is therefore reduced.

To influence this load-limiting function by addition or subtraction, a torque can be applied to the rotatable spool 10 or the load limiter 11 via a coupling 9. It is also possible to transmit torques to the belt reel 1, in particular the rotatable spool 10 via this coupling 9 for pretensioning and/or power tensioning of the seat belt 5. Processes of this type, during which torques are transmitted via the coupling 9 to the load limiter 11 and/or the belt reel 1, in particular the rotatable belt part 10, are described in German patent applications DE 199 27 731 A1, 199 40 034 A1, 199 50 855 A1 and in German patent DE 197 31 689 C2.

The transmitted torques are supplied by a rotor 2 on the other side of the coupling. This rotor 2 is mounted rotatably on a bearing journal 14. The bearing journal 14 is connected non-rotatably to the spool 10. In the embodiments illustrated, the bearing journal 14 comprises an axial extension of the load limiter 11 that is a torsion bar. The rotor 2 has a bearing collar 15. The bearing collar is mounted rotatably on the bearing journal 14. At its exterior, the bearing collar 15 is mounted rotatably in a cylindrical outer bearing 12 formed by an internal bore in an adapter flange 13. The adapter flange 13

is connected rigidly to the retractor frame 3 at fixing points 39.

On the rotor 2 there is also provided a radially extending plane rotor face 43 which rests with an interlocking fit on a correspondingly designed contact face 44 also extending radially with respect to the reel axis 4 on the adapter flange 13. Security against axial displacement in both axial directions for the rotor 2 in the embodiment in Fig. 1 is ensured in the embodiment shown in Fig. 1 by a securing ring 45 (Fig. 1). The securing ring is supported on the bearing journal 14 or, as will be described in detail, on the casing 20 and therefore on the adapter flange 13. In the embodiment shown in Fig. 2 a securing disc 32 is provided which rests on a contact face 46 of the adapter flange 13 located on the side of the adapter flange 13 opposite the contact face 44 (Fig. 2).

The bearing journal 14 is also supported by an external securing disc 31 on the exterior of the casing 20 connected rigidly to the adapter flange 13. (Figs. 2 and 3) In the three embodiments, the bearing journal 14 has, at the end at which is connected to the load limiter 11 and which merges integrally into the load limiter, a peripheral stop 17 in the form of a peripheral shoulder. In the embodiment in Fig. 1, the rotor 2 is secured axially between the securing disc 45 and the peripheral stop 17 and held on the bearing journal 14. As the rotatable spool 10 is connected rigidly to the bearing journal 14 via the connecting point 30 and on a plane contact face 46 that extends radially to the reel axis 4 and rests on the side of the adapter flange 13 opposed to the

contact face 44, the belt reel 1 is also secured axially and supported on the adapter flange 13.

An annular carrier 6 guides coupling elements 7 between a released position and an engaged position is provided in the embodiment shown in Fig. 1. This annular carrier 6 is shaped integrally on the end face of the spool 10. The annular carrier 6 is extended beyond the width required for forming the coupling and projects into a correspondingly shaped recess of the adapter flange 13. The extended annular carrier 6 is mounted rotatably in this recess. In the axial direction, the carrier is secured in an interlocking manner by a double needle 33. For this purpose, a peripheral half-round groove is shaped in the extension of the annular carrier 6. The other half of the needle is plugged in rectilinear bores shaped in the adapter flange 13.

The half-round grooves or bores in the adapter flange 13 oppose the peripheral half-round groove in the extended carrier 6 so that a friction-free interlocking connection is achieved in both axial directions during insertion of the securing double needle 33. As a result, perfect support and introduction of the forces which act on the coupling during the transmission of torque and which can lead to a change in the desired position of the coupling, is achieved by and in the adapter flange 13.

In the embodiment shown in Fig. 2, the annular carrier 6 for the coupling element 7 is connected to the spool 10 by a press fit. For this purpose, the annular carrier 6 has a conically shaped peripheral pressed part 47 which is inserted with pressure into the through bore in the spool 10. The connecting

point 30 is produced between the pressed part 47 and the load limiter 11 is a torsion bar, for example by wedging teeth or the like. As in the embodiment in Fig. 1, the bearing journal 14 comprises, in particular in the region of the transition to the load limiter 11, a peripheral stop face 17 against which the annular carrier 6 rests. The axial securing of the unit comprising the belt reel 1, the load limiter 11, the annular carrier 6 and therefore the coupling 9 and the bearing journal 14 is effected in one direction by a securing disc 31 supported on the casing 20. As the casing 20 is fastened on the adapter flange 13 the unit is supported on the adapter flange 13 in one axial direction. The unit is supported on the contact face 46 of the adapter flange in the other axial direction. The annular carrier 6 for the coupling elements 7 rests on this contact face 46. As in the embodiment in Fig. 1, therefore, the forces which act during the transmission of torque at the coupling 9 and which could lead to a change of position of the coupling 9 are supported flat on the adapter flange 13 in both axial directions. Optionally, the rotor 2 can be supported with an additional securing disc 32 on the contact face 46 of the adapter flange 13. On the other side of the adapter flange 13, the rotor 2 rests with a radially extending face on the contact face 44 of the adapter flange 13. In cooperation with the securing disc 32, therefore, the rotor 2 is supported on the adapter flange 13 in a radial direction as well as in both axial directions.

In the embodiment shown in Fig. 3, the bearing collar 15 of the rotor 2 extends beyond the coupling 9

in the direction of the spool 10. The rotor 2 is supported at the peripheral contact face 17 on the bearing journal 14 or at the transition from the bearing journal 14 into the load limiter 11 and/or on a further peripheral contact face 48 provided on the spool 10 in one axial direction. As in the embodiment in Fig. 2, the bearing journal 14 is supported on the casing 20 rigidly connected to the adapter flange 13. The annular carrier 6 for the coupling element 7 is shaped integrally on the spool 10 and rests flat on the contact face 46 on the side of the adapter flange 13 facing the belt reel 1. As in the embodiments in Figs. 1 and 2, the unit comprising the belt reel 1, the load limiter 11, the bearing journal 14 and the coupling 9 with its annular carrier 6 is supported on the adapter flange on both sides. For supporting the rotor 2 on the adapter flange 13 on both sides, an additional securing disc 32 rests on the contact face 46 turned toward the belt reel 1 and is optionally arranged between the annular carrier 6 and the contact face 46 can also be provided as in the embodiment in Fig. 2.

In the embodiments in Figs. 1 and 2, the torque transmitted from the rotor 2 to the spool 10 or the load limiter 11 is produced by an electric motor 22 preferably a brushless d.c. motor of the type described in detail in DE 43 02 042 A1.

The electric motors 22 in these two embodiments are external rotor motors in which stator poles 26 are arranged on an internal radius on a stator carrier 21 and rotor poles 25 are arranged on an external radius with formation of an air gap 40 on a hood-shaped motor rotor (external rotor) 8. The stator carrier 21 is

fastened on the adapter flange 13 and is annular in design. The teeth of a ring gear 34 for forming a planetary gear within the stator carrier are located on the interior of the annular stator carrier. The non-rotatable connection between the annular stator carrier 21 and the adapter flange 13 can be achieved by interlocking engagement of teeth with the teeth extension of the ring gear 34, as shown in Figs. 1 to 3.

To complete the planetary gear, the rotor 2 is a planet wheel carrier on which planet wheels 35 are rotatably arranged. The planet wheels 35 engage with the ring gear 34 and with a sun wheel 36 formed on a bearing collar 51 of the hood-shaped motor rotor 8. With a design of this type, as shown in Fig. 1, the rotor 2 can also be supported on the casing 20, for example on the interior of the casing 20, via the gear parts and the hood-shaped motor rotor 8 which is supported on the interior of the housing 20 by a pivot bearing 38.

In the embodiment shown in Fig. 3, the rotor poles 25 are fastened on an internal motor rotor 18. The stator poles 26 provided on the stator carrier 31 are located on an external radius. In the embodiments of the electric motors 22 shown in Figs. 1, 2 and 3, the rotor poles 25 provided on the motor rotors are preferably permanent magnets and the stator poles 26 as field windings. Brushless d.c. motors are preferably used.

Torques can be generated by the electric motors 22 in the embodiments, in order to bring about reversible pretensioning of the seat belt, should the risk of a crash arise (probability of a crash), in

order to influence the load limiter 11 by addition or subtraction and to adjust the comfort of the bias produced by the motive spring 19. As already explained, the motive spring 19 acts via the spring core 37 which is connected non-rotatably to the bearing journal 14 and via the connecting point 30 on the belt reel 1.

Rather than an electric motor force, a torque resulting from an inertial force can also be transmitted via the rotor 2 and via the coupling 9 to the belt reel 1. For this purpose, the rotor 2 can be an inert mass or can be connected rotatably to an inert mass, as described, for example, in DE 199 50 855 A1.

Hall sensors 24, by which the respective rotational angle position of the motor rotor 8 or 18 can be scanned, can be provided on the adapter flange 13. These Hall sensors 24 are so arranged that they are influenced by the magnetic field of the respective rotor poles 25. Preferably, the Hall sensors 24 can be used for controlling switching of the brushless d.c. motor 22. It is also possible when adjusting the bias formed by the motive spring 19 to evaluate the signals from the Hall sensors 24 and to use them for controlling the motive spring force. The motive spring force is adjusted in a known manner by relocating the external fixing point of the motive spring 19 that can be connected non-rotatably to the motor rotor 8 or 18.

A mechanical serration 23 that is supported on the adapter flange 13 and can be resilient in design can also be provided between the motor rotor 8 or 18 and the adapter flange 13. A secure mounting position

of the motive spring 19 via the motor rotor on the adapter flange 13 can thus be achieved. The motor rotor 8 or 18 can also be fixed in an optimum starting position which is predetermined in each case by the division ratios of the rotor poles and the stator poles.

The mode of operation of the coupling 9 is as follows. If the blocking discs 41, 42 are fixed against further rotation by engagement of a blocking latch (not shown in detail) in the blocking teeth 27, for example in the event of a crash, and the spool 10 is rotated in the belt extraction direction owing to the forward displacement of the strapped-in vehicle occupant's body, the coupling elements 7 are displaced radially inwardly from their normal position shown in Fig. 4 owing to the relative rotation between the spool 10 or the carrier 6 and the fixed blocking disc 42. The coupling elements 7 are displaced radially inwardly into the engagement recesses 16 provided in the bearing collar 15 of the rotor 2. The rotor 2 is therefore coupled to the rotatable spool 10 by the carrier 6. A suitable coupling is known, for example, from DE 196 47 841 A1.

In the embodiment shown in Fig. 5, a damping device 50 with a viscous damping means, for example oil, is provided between the external rotor 8 of the electric motor, and the adapter flange 13. One rotor part projects into the viscous damping means so that the initial torque which the rotor transfers to the rotatable spool 10 or the load limiter 11 is brought into effect in a dampened fashion. In the embodiment illustrated, the damping device 50 is located between the adapter flange 13 or the stator carrier 21 and the

motor rotor 8. Instead of the electric motor, the rotor 8 can also act as an inert mass on the rotatable spool 10 or the load limiter 11, as described in DE 199 50 855 A1. A magnetic or mechanical damping medium can be used in the damping device 50 rather than a viscous damping medium.

The rotor 8 is also mounted rotatably essentially by the external bearing 12 provided on a bearing collar 49 of the adapter flange 13 in the embodiment shown in Fig. 5. The coupling 9 and, in particular, the annular carrier 6 of the coupling, is supported axially on the contact face 46 of the adapter flange 13.

Claims:

1. A seat belt retractor for a seat belt (5), with a belt reel (1), mounted rotatably around a reel axis (4) on a retractor frame (3) and biased by a motive spring (19), a load limiter (11) non-rotatably connected to a rotatable spool (10) of the belt reel (1) and a rotor (2; 8) which can be coupled to the belt reel (1) and/or the load limiter (11) by a coupling (9), wherein the coupling (9) comprises an annular carrier (6) connected non-rotatably to the belt reel (1) and/or the load limiter (11) for guiding coupling elements (7) between a released and an engaged position, characterised in that the annular carrier (6) is arranged coaxially around a bearing collar (15) provided on the rotor (2) and is supported against axial displacement on the adapter flange (13).

2. A seat belt retractor according to claim 1, characterised in that the rotatable spool (10), the load limiter (11), the bearing journal (14) and the carrier (6) for guiding the coupling elements (7) between a released and an engaged position form a non-rotatably interconnected unit which is supported on either side of the adapter flange (13).

3. A seat belt retractor according to one of claims 1 or 2, characterised in that engagement recesses (16) for the coupling elements (7) in the engaged position are provided in the axial region of the bearing collar (15) of the rotor (2) overlapped by the annular carrier (6), the rotor (2) and the annular

carrier (6) being non-rotatably connected by the coupling elements (7) in the engaged position.

4. A seat belt retractor according to one of claims 1 to 3, characterised in that the annular carrier (6) is supported on a peripheral stop (17 and/or 48) on the rotatable spool (10) or in the transition region between the load limiter (11) designed as a torsion bar and the bearing journal (14) connected integrally thereto.

5. A seat belt retractor according to one of claims 1 to 4, characterised in that the rotor (2) transmits a torque generated by an electric motor (22).

6. A seat belt retractor according to claim 5, characterised in that a motor rotor (8 or 18) of the electric motor (22) is mounted rotatably on the bearing journal (14) and is an external rotor or internal rotor.

7. A seat belt retractor according to claim 6, characterised in that, between the motor rotor (8 or 18) and the adapter flange (13) a mechanical serration (23) is provided, which is supported on the adapter flange (13) and by which the motor rotor can be stopped.

8. A seat belt retractor according to one of claims 6 or 7, characterised in that the motor rotor (8 or 18) can be stopped in specific rotational angle positions by the mechanical serration (23) in which a

startup of the electric motor (22) is ensured owing to the division ratio of the rotor and stator poles (25, 26).

9. A seat belt retractor according to one of claims 5 to 8, characterised in that the electric motor (22) is a brushless d.c. motor.

10. A seat belt retractor according to one of claims 5 to 9, characterised in that on the adapter flange (13) there are arranged Hall sensors (24) which are influenced by the magnetic field of the respective rotor poles (25) and which control the switching of the brushless d.c. motor (22).

11. A seat belt retractor according to claim 10, characterised in that the bias or restoring force of the motive spring (19) is adjustable as a function of the rotational angle signals of the Hall sensors (24) via the motor rotor (8 or 18) acting on the outer fixing point of the motive spring (19).

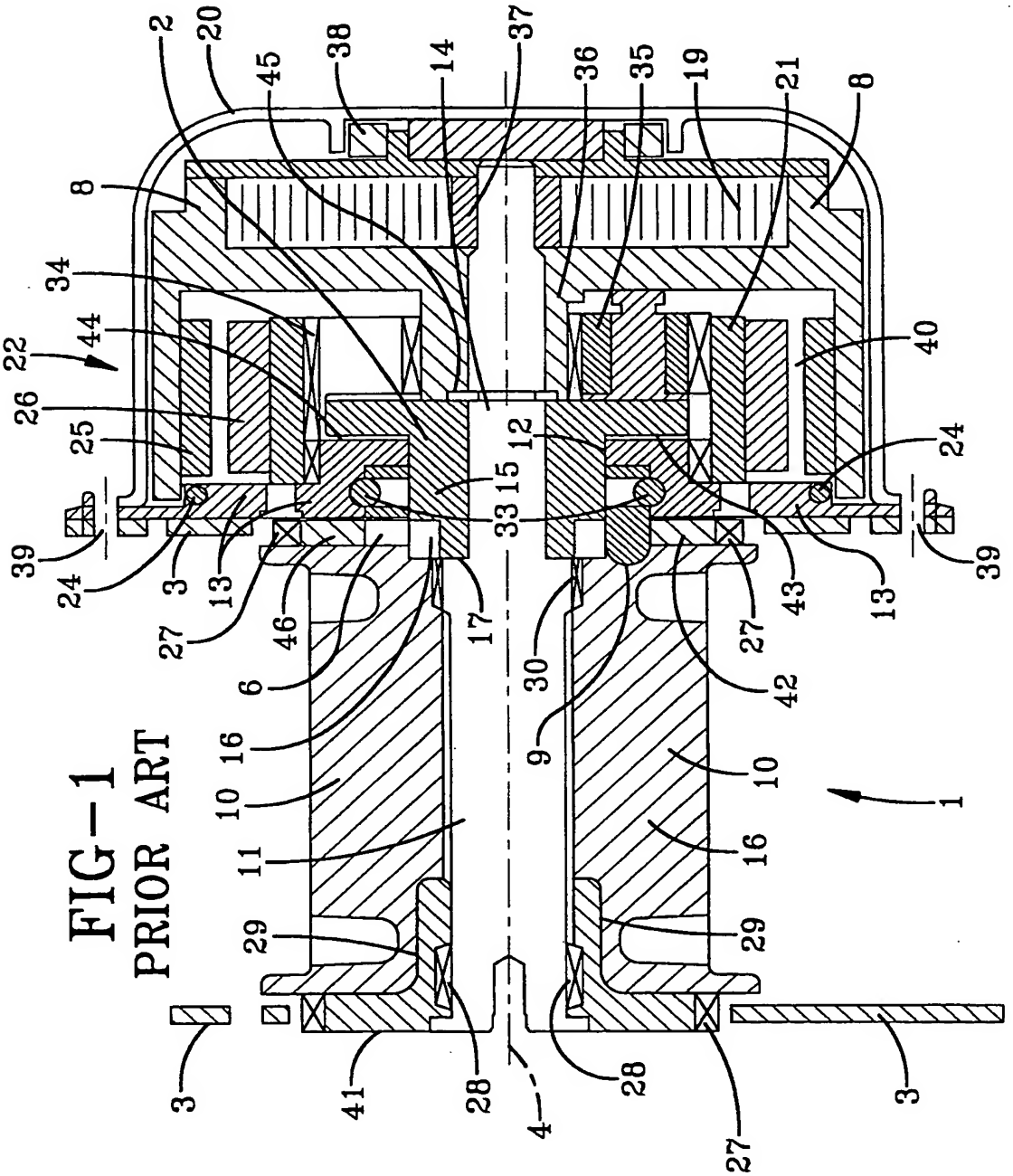


FIG-1
PRIOR ART

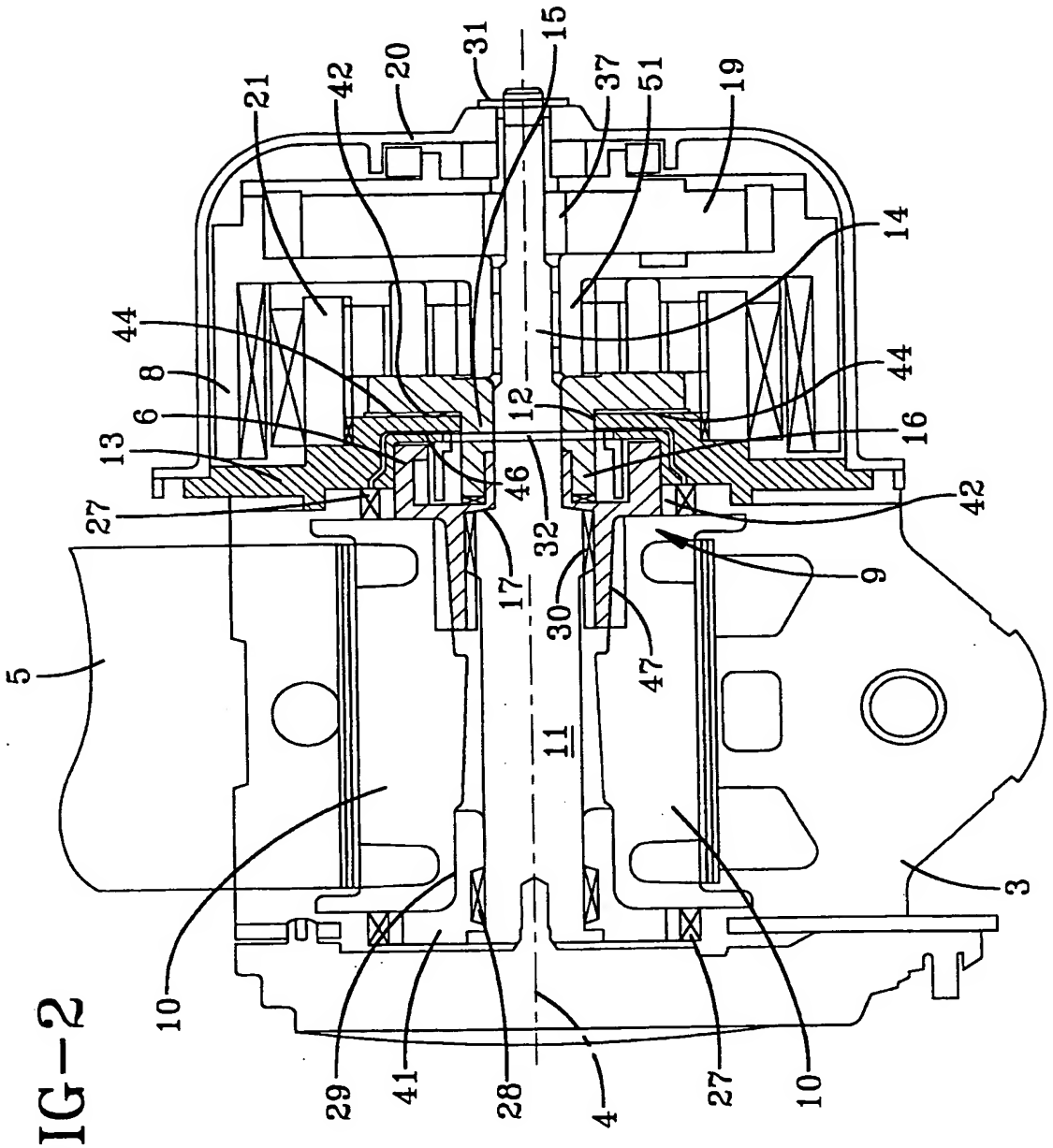

21
42
20
31
15
37
51
19
14
44
8
6
13
12
44
16
27
46
32
42
17
30
9
47
5
11
3
10
29
41
28
4
27
10

FIG-2

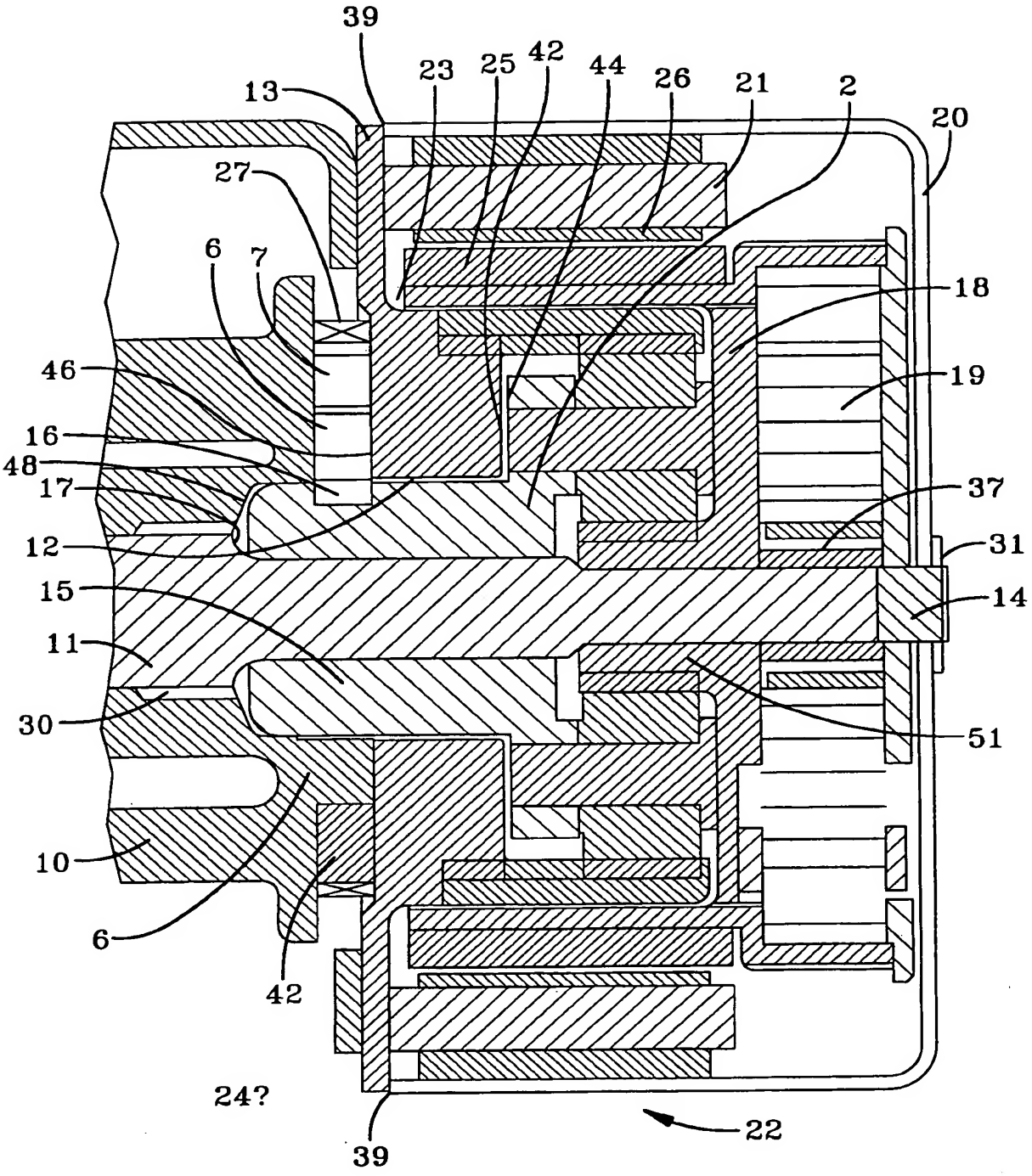

39
23
25
42
44
26
21
2
20
13
27
6
7
18
46
19
16
48
17
37
12
31
15
14
11
30
51
10
6
42
24?
22
39

FIG-3

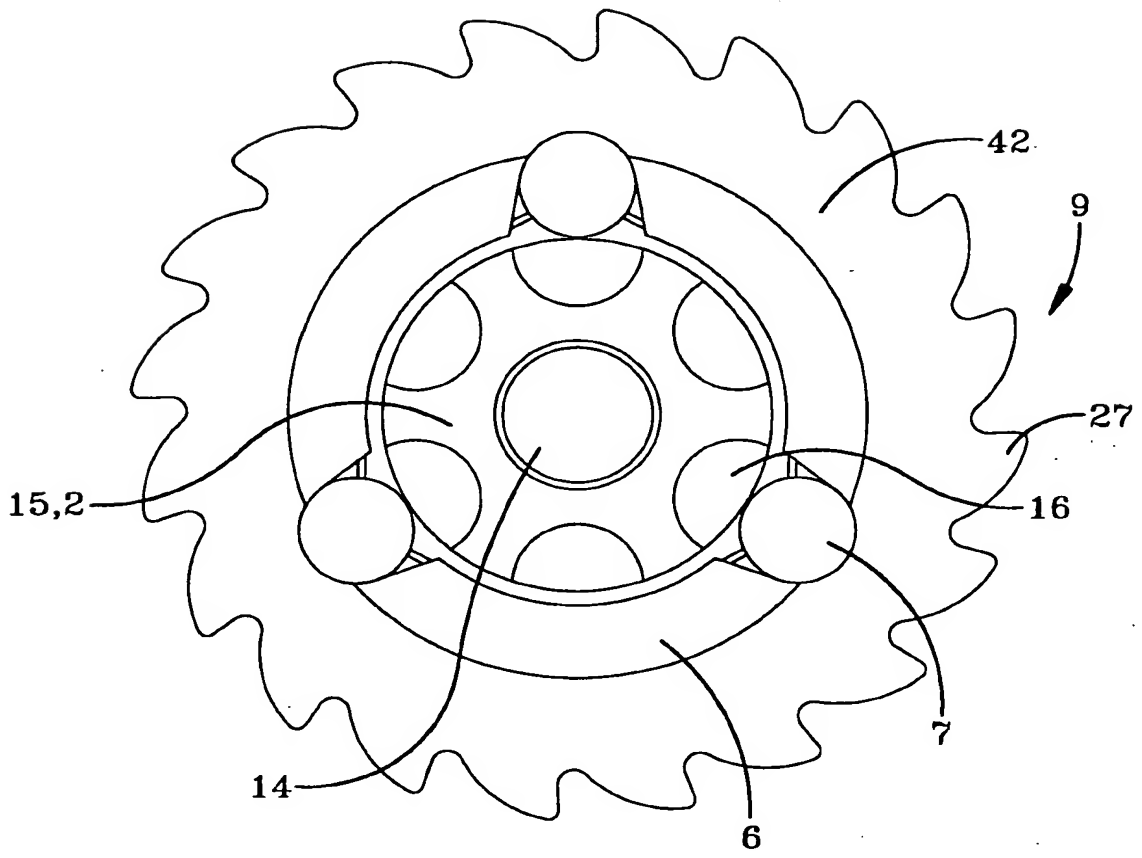


FIG-4

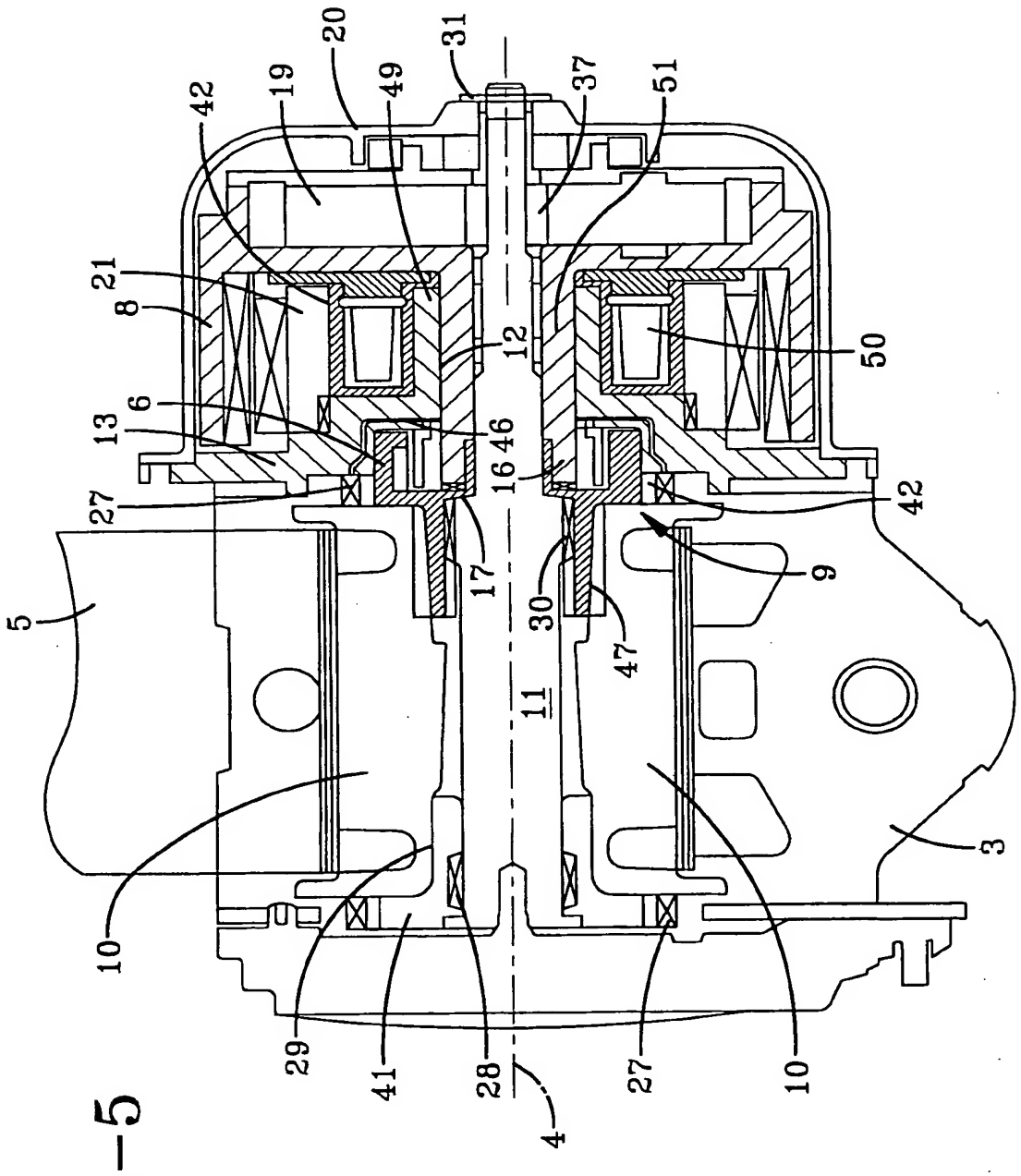

20
31
19
49
37
51
42
21
8
12
50
6
13
16
46
27
42
17
9
5
30
47
11
3
10
29
41
28
27
10
4

FIG-5

INTERNATIONAL SEARCH REPORT

Inter ɔnal Application No
PCT/US /29492

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R22/34 B60R22/28 B60R22/44 B60R22/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 196 47 841 A (HS TECH & DESIGN) 20 May 1998 (1998-05-20) cited in the application the whole document ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 11, 30 September 1998 (1998-09-30) & JP 10 167002 A (TAKATA KK), 23 June 1998 (1998-06-23) abstract; figures ---	1
A	DE 197 31 689 A (HS TECH & DESIGN) 4 February 1999 (1999-02-04) cited in the application the whole document --- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 January 2001	01/02/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dubois, B

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter[illegible]nal Application No
PCT/US[illegible]/29492

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	EP 1 022 201 A (BREED AUTOMOTIVE TECH) 26 July 2000 (2000-07-26) paragraph '0019! - paragraph '0020!; figure 2	1

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

...ormation on patent family members

Inter...nal Application No
PCT/US...29492

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19647841 A	20-05-1998	EP 0842831 A	20-05-1998
JP 10167002 A	23-06-1998	NONE	
DE 19731689 A	04-02-1999	EP 0893313 A	27-01-1999
EP 1022201 A	26-07-2000	DE 19902483 A WO 0043245 A	17-08-2000 27-07-2000